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Liquid Cooling in Data Centers: Why Temperature Sensing Is the Deciding Factor

Introduction

Data centers are no longer simply about racks, fans, and airflow. With the rapid growth of high-performance computing, particularly artificial intelligence and machine learning, the rules of thermal management have changed. Today's processors demand more power, more density, and create more heat than air-cooling systems were ever designed to handle.

This shift has opened the door to liquid cooling. Once seen as a niche approach, it is quickly becoming mainstream. Bloomberg projects that the Coolant Distribution Unit (CDU) market will grow at a 40% CAGR through 2028, while surveys from the Uptime Institute show 17% of data centers already using liquid cooling, with more than 60% planning adoption. It's clear that liquid cooling is not a question of if it's a question of when.

At the heart of this transformation lies one critical component: the CDU. And at the heart of every CDU is something even more fundamental, temperature sensing.

What Makes a CDU the Backbone of Liquid Cooling?

A CDU is more than a pump or a pipe junction. It's the control center that makes liquid cooling viable in high-density environments. Its job is simple to describe but complex to execute manage coolant distribution, stabilize pressure and flow, and keep temperature where it needs to be, no higher, no lower.

By separating the primary chilled-water loop of a facility from the secondary IT loop, a CDU provides isolation, stability, and protection. It ensures the fluid running through cold plates or rear-door heat exchangers never threatens sensitive IT hardware with condensation or contamination. Whether deployed in-rack or in-row, the CDU is what allows operators to confidently scale into AI-ready facilities.

Cooling Technologies That Depend on CDUs

Once CDUs are in place, a range of liquid cooling strategies open up:

- Direct-to-Chip (D2C): Coolant flows directly through cold plates mounted on CPUs and GPUs, extractinheat at the source.
- Immersion Cooling: Entire servers are submerged in dielectric fluid, eliminating the need for most fans and improving density.
- Pumped Two-Phase (P2P): By leveraging phase change, P2P systems push efficiency further, handling extreme heat loads with smaller footprints.

These are powerful tools, but none of them work effectively without precise control at the CDU.

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Why Temperature Sensing Is the Enabler

If the CDU is the brain of the system, temperature sensors are its nervous system. Every decision, whether to increase flow, adjust valves, or trigger an alarm, depends on accurate, real-time temperature data.

Temperature sensing enables:

- Maintaining setpoint stability in the IT loop.
- Measuring ΔT across inlets and outlets to gauge cooling efficiency.
- Protecting equipment from pump failures, blockages, or facility fluctuations.
- Reducing energy costs by avoiding overcooling.
- Feeding telemetry into DCIM/BMS platforms for predictive maintenance and optimization.

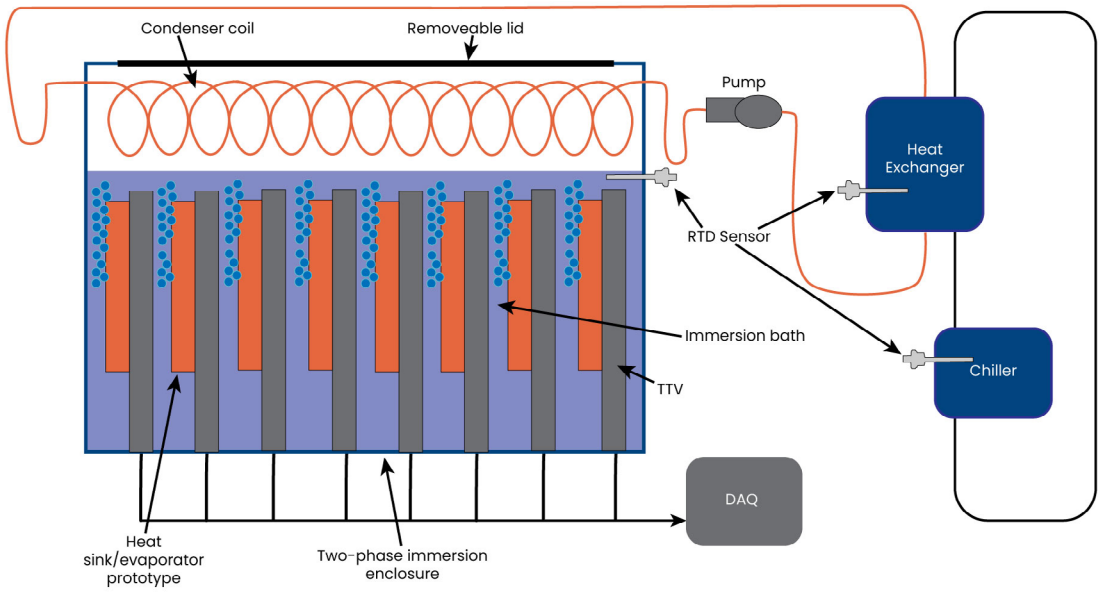
Even a half-degree Celsius error can mean wasted energy, higher costs, or in the worst case, server downtime. In a world where AI workloads are pushing hardware to its thermal limits, accuracy is everything.

Where do Sensors Belong in a CDU?

A properly designed CDU integrates sensors across every critical node:

- Primary loop: Inlet and outlet sensors track chilled-water conditions and ΔT compliance.
- Secondary loop: Supply and return sensors protect cold plates and racks, with redundancy on supply for reliability.
- Heat exchanger: Sensors validate thermal transfer efficiency.
- Reservoir and pump housing: Bulk monitoring prevents pump overheating and coolant anomalies.

This isn't just about numbers on a screen. It's about creating a system that reacts instantly, learns over time, and provides operators the confidence that their cooling is not only running but running right.



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Why Platinum RTDs Are the Gold Standard

When it comes to temperature sensing in CDUs, the choice of technology matters. Thermocouples and thermistors are often cheaper, but they don't offer the stability or accuracy required in hyperscale environments. Platinum Resistance Temperature Detectors (Pt RTDs) have become the clear standard for three reasons:

1. **Accuracy and Stability:** Pt RTDs deliver ±0.1–0.2 °C precision, exactly the range ASHRAE and hyperscalers demand. And they maintain this accuracy for years, not months.
2. **Reliability in Harsh Environments:** Platinum's inertness ensures sensors don't corrode, oxidize, or drift, even in treated or humid water loops.
3. **Standardization and Interchangeability:** Pt100 and Pt1000 elements align to IEC 60751, meaning they integrate seamlessly across CDU platforms worldwide.

The result? Repeatable, noise-resistant, and trustworthy data, the kind of data that AI-driven cooling control systems depend on.



Tailoring Sensors for CDU Applications

Not every CDU is the same, and neither should every sensor assembly be. YAGEO Nexensos delivers sensors that are not just accurate but also adaptable to real-world integration challenges:

- Compact form factors for in-rack and in-row CDU designs.
- Pressure- and corrosion-resistant housings that extend operational lifetime.
- Fast-response assemblies that catch ΔT shifts in real time.
- Plug-and-play designs with optimized connectors and cables that simplify installation.
- DIN/ISO standard elements help replacement and aftermarket needs for the complete product lifecycle

This ability to customize ensures operators aren't just getting a sensor, they're getting a sensing solution built for their environment.

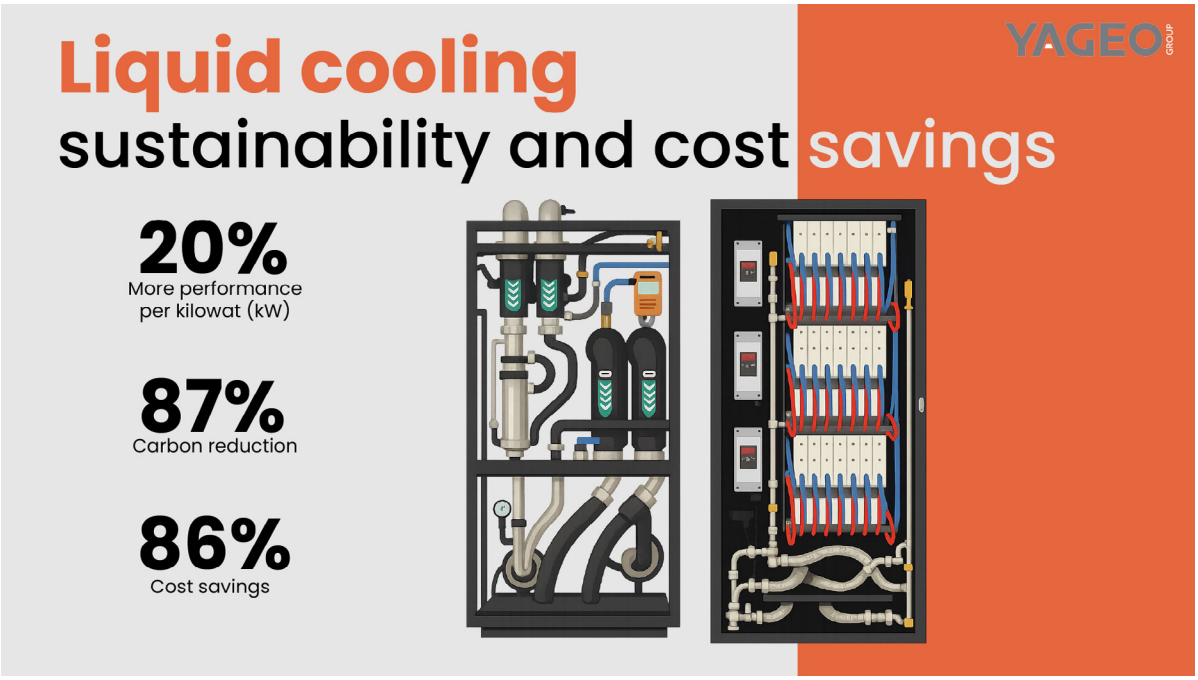
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Why This Matters for Data Centers Today

Thermal management has become one of the top causes of downtime in data centers. Too warm, and servers throttle or fail. Too cold, and operators waste energy and money.

Industry standards such as ASHRAE and OCP have made it clear: temperature monitoring within ±0.2 °C is no longer optional. Hyperscalers often go further, targeting ±0.1 °C to squeeze every ounce of efficiency into their PUE metrics.

This is why precision temperature sensing isn't a detail. It's the deciding factor in whether liquid cooling delivers on its promise of efficiency, reliability, and scalability.



Conclusion

The industry has reached a tipping point. Air cooling alone cannot keep up with the demands of AI and HPC. Liquid cooling is here, and CDUs are the linchpin that make it possible.

But the real story isn't just pumps, pipes, or heat exchangers. It's data, the ability to sense, control, and adapt in real time. And that data begins with temperature.
By deploying CDUs with robust, redundant, and highly accurate sensing strategies, operators unlock:

- Higher energy efficiency.
- Greater scalability to meet AI-driven demand.
- Improved uptime and reliability.

At YAGEO Nexensos, we see temperature sensing not as a component but as the foundation of liquid cooling. With platinum thin-film technology, customizable assemblies, and proven reliability, we help data centers move forward with confidence, because in the race to power tomorrow's AI, every degree counts.